Physical Activity and Air Pollution Exposure

Tegan K. Boehmer, PhD, MPH
Senior Research Scientist

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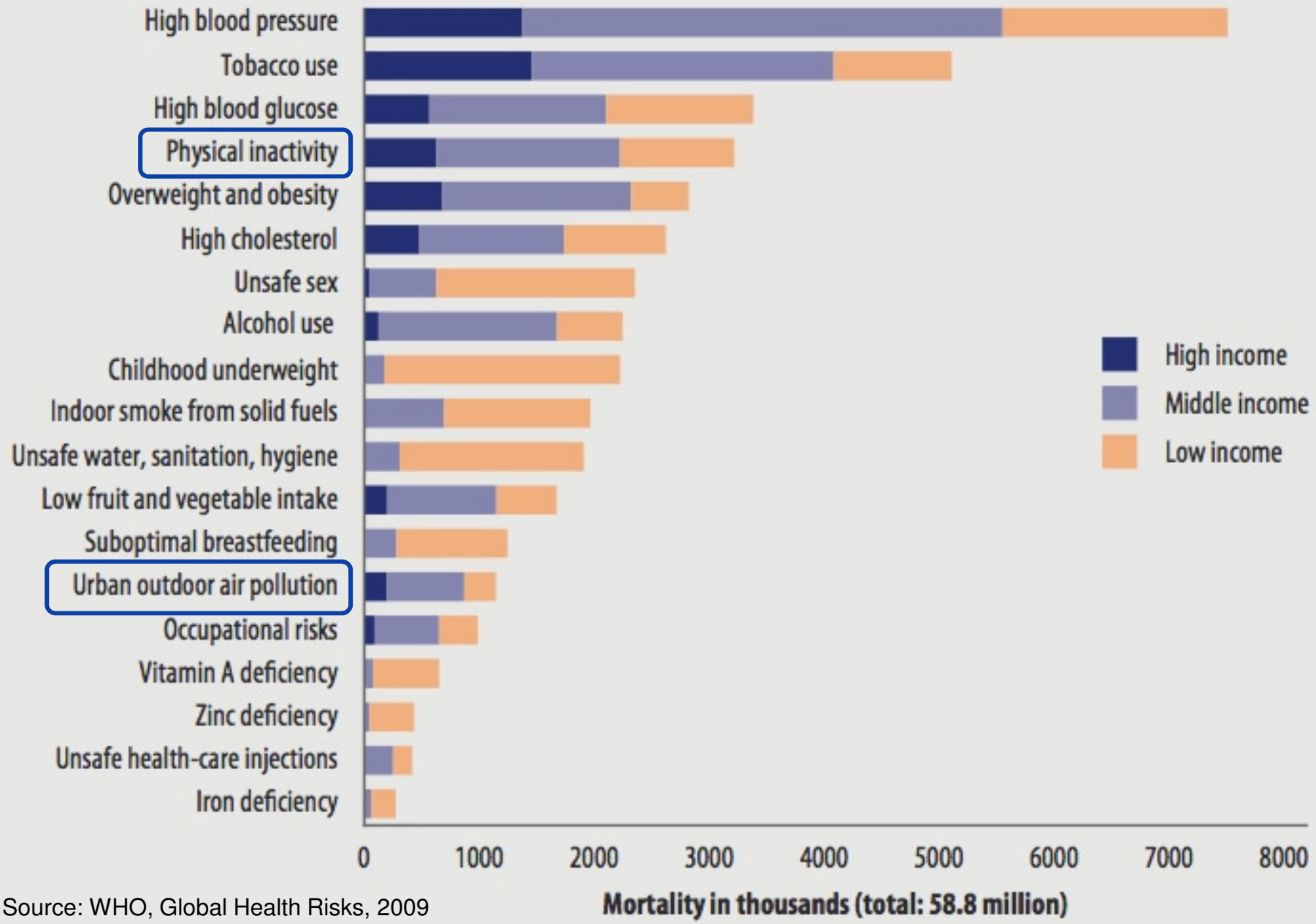
National Center for Environmental Health
Division of Environmental Hazards and Health Effects

Objectives

- Summarize health benefits of physical activity and public health recommendations
- Discuss public health significance of air pollution exposure while being physically active
- Provide an overview of CDC activities

PHYSICAL ACTIVITY

Figure 6: Deaths attributed to 19 leading risk factors, by country income level, 2004.



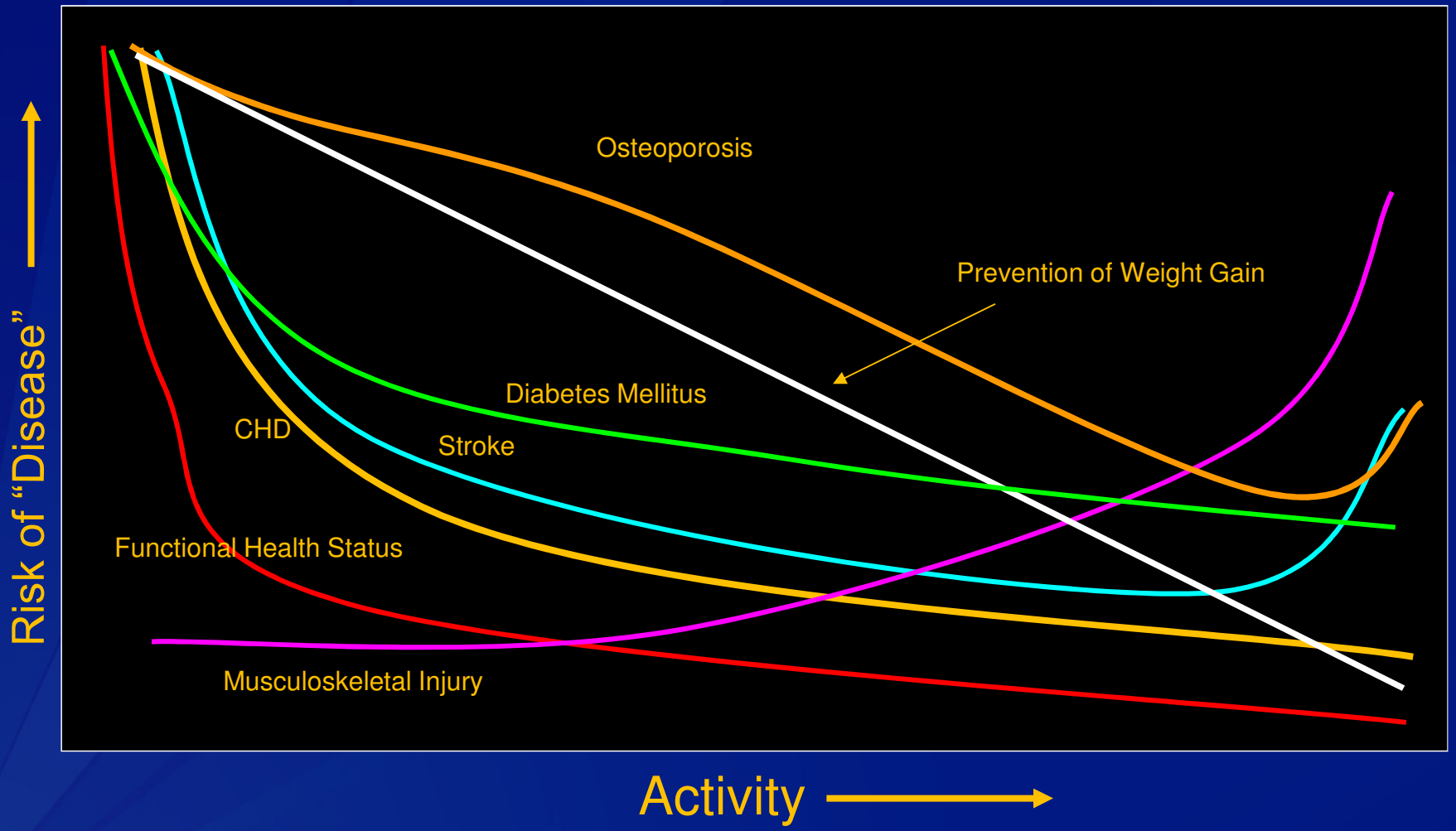
Source: WHO, Global Health Risks, 2009

Benefits of Physical Activity

- **In adults, physical activity lowers risk for:**
  - Premature death
  - Coronary heart disease
  - Stroke
  - Hypertension
  - Type 2 diabetes
  - Colon cancer
  - Breast cancer
  - Depression
  - Unhealthy weight gain
  - Injuries from falls
- **In children and adolescents, physical activity is associated with improved:**
  - Cardiorespiratory fitness
  - Bone health
  - Cardiovascular biomarkers
  - Metabolic health biomarkers
  - Academic achievement
  - Academic behaviors
  - Cognitive skills

1. U.S. Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. October 2008. http://www.health.gov/paguidelines/.
2. Centers for Disease Control and Prevention. The association between school-based physical activity, including physical education, and academic performance. 2010. http://www.cdc.gov/healthyyouth/health_and_academics/pdf/pa-pe_paper.pdf

Benefits of Physical Activity



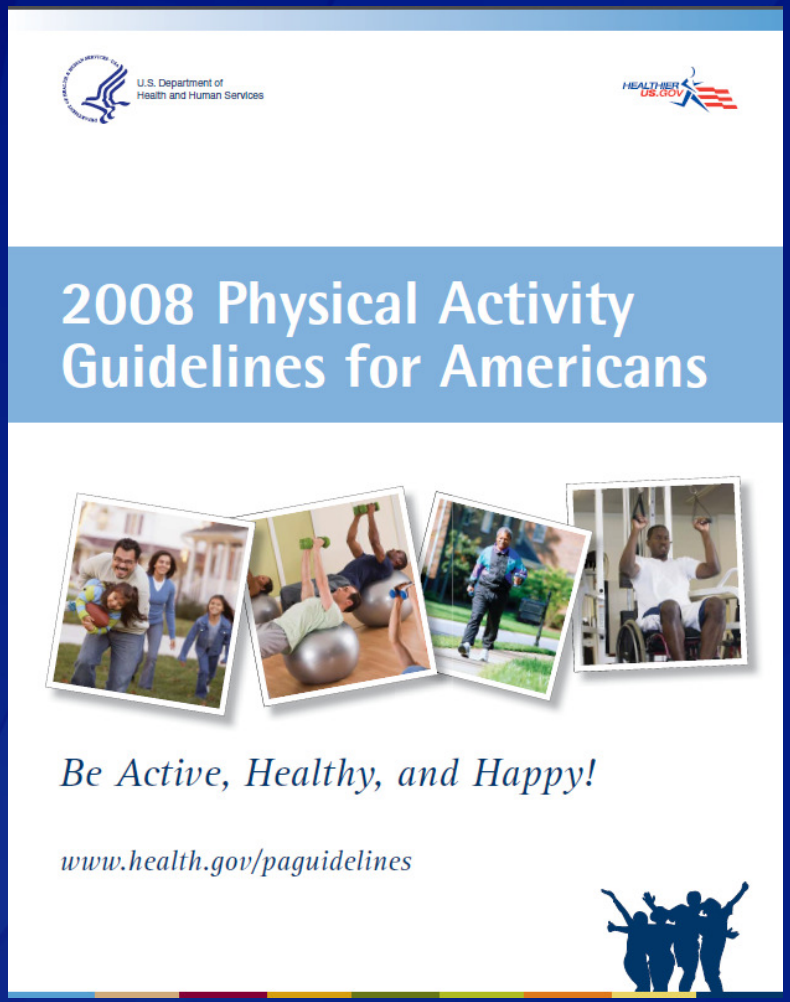
Source: HW Kohl, University of Texas School of Public Health

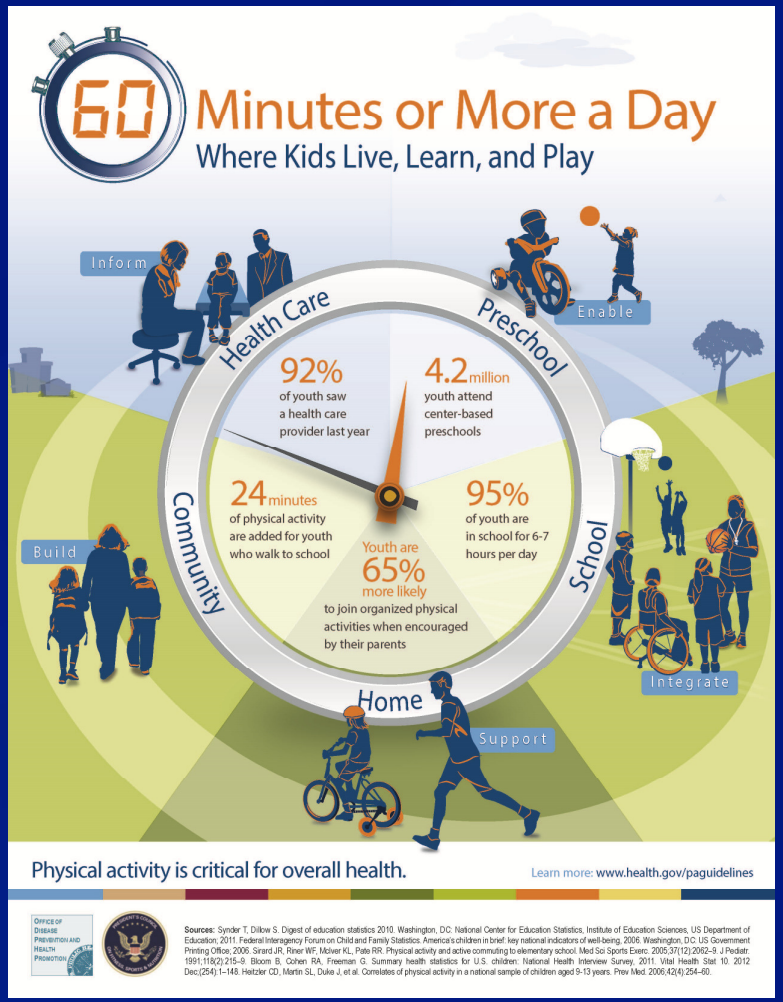
Public Health Impacts of Physical Inactivity

- 36% of adults report no leisure-time physical activity
- 82% of adults and 88% of adolescents do not meet current federal guidelines for aerobic activity and muscle strengthening
- Estimated medical cost of physical inactivity = $75 billion per year

1. CDC National Health Interview Survey
2. CDC Youth Risk Behavior Surveillance System 2009
3. http://www.cdc.gov/chronicdisease/resources/publications/aag/nutrition.htm

Physical Activity Guidelines for Americans (US DHHS)





www.health.gov/paguidelines

Physical Activity Guidelines Children and Adolescents (6–17 yrs)

- **60+ minutes of physical activity every day**
  - Aerobic: Most of 60+ minutes should be moderate- or vigorous-intensity aerobic physical activity, with vigorous-intensity activity at least 3 days per week.
  - Muscle-strengthening: at least 3 days of the week
  - Bone-strengthening: at least 3 days of the week
- **Encourage participation in physical activities that are age appropriate, enjoyable, and offer variety**

Physical Activity Guidelines Adults (18–64 yrs)

- **Avoid inactivity. Health benefits are seen with any amount of physical activity.**
- **Substantial health benefits seen with:**
  - 150 min/week of moderate-intensity aerobic activity
  - 75 min/week of vigorous-intensity aerobic activity
  - Activity episodes for at least 10 minutes, throughout week
- **Additional health benefits seen with:**
  - 300 min/week of moderate-intensity aerobic activity
  - 150 min/week of vigorous-intensity aerobic activity
- **Muscle-strengthening activities at least 2 days/week provide additional benefits**

Physical Activity Guidelines Older Adults (65+ yrs)

- **Same four principles on previous slide, but additional qualifying guidelines:**
  - Guidance for adults who cannot do 150 min/week
  - Use relative intensity to determine level of effort
  - Be aware of chronic conditions and injury risk
  - Recommend balance exercises for persons at risk of falling

Physical Activity Guidelines
Chapter 6: Safe and Active

- Exposure to air pollution is associated with several adverse health outcomes, including asthma attacks and abnormal heart rhythms.
- People who can modify the location or time of exercise may wish to reduce these risks by exercising away from heavy traffic and industrial sites, especially during rush hour or times when pollution is known to be high.
- However, current evidence indicates that the benefits of being active, even in polluted air, outweigh the risk of being inactive.

AIR POLLUTION EXPOSURE WHILE BEING ACTIVE

How Physical Activity Affects Air Pollution Dose

- **Concentration varies across microenvironments**
  - When and where activity occurs
- **Time spent in microenvironment**
  - Duration of activity (e.g., active travel vs. driving)
- **Ventilation rate correlates with intensity of activity**
  - Increased ventilation rate: more breaths/minute
  - Increased velocity of breaths: forces air deeper into lungs and increases deposition fraction
  - More mouth breathing: bypasses nasal filtration
- **Dose is dependent on age, sex, and body size**

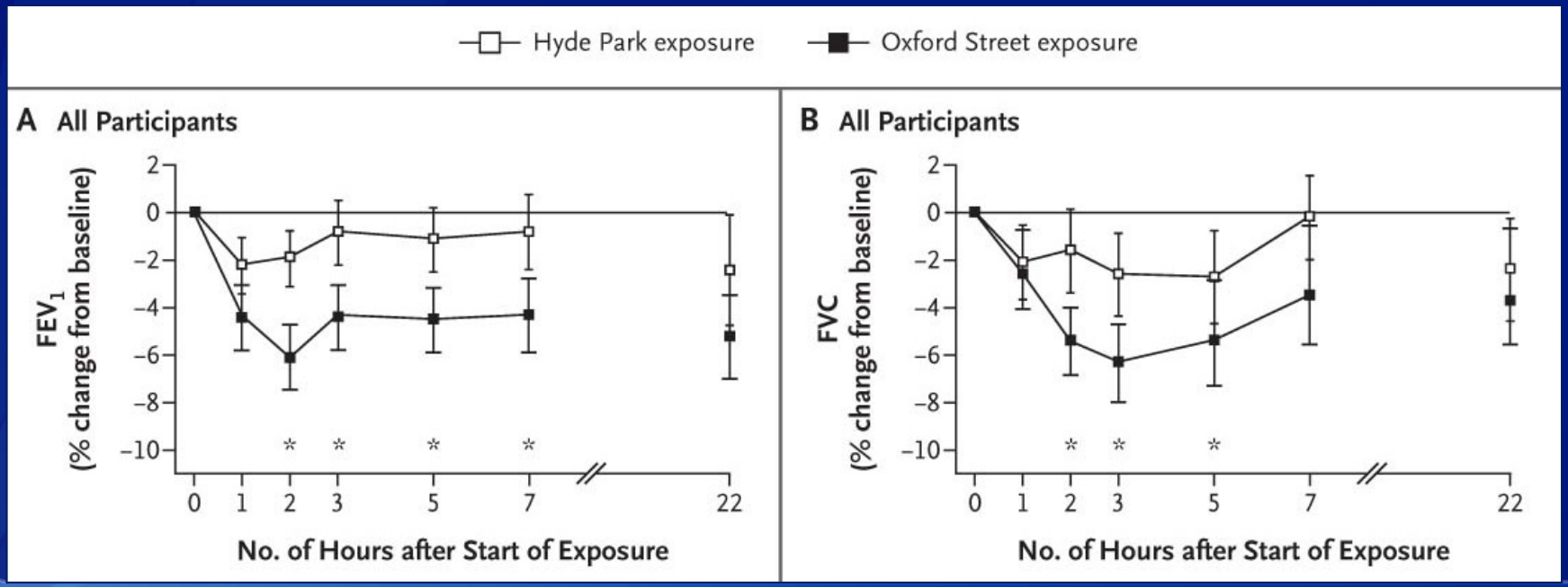
Giles and Koehle, Sports Med 2013.

Air Pollution & Physical Activity Joint Health Effects

- **Mortality risks vs. benefits**
  - Studies on increasing active travel consistently show that benefits (physical activity) > risks (air pollution and injury)
  - Modeled predictions of hypothetical scenarios using relative risk data from literature
- **Interaction effects are not well studied**
  - Short-term exposure and acute health effects
  - Long-term exposure and chronic health effects
- **Built environment plays an important role in determining air pollution and physical activity levels**

Short-term Exposure and Lung Function

- 60 adults with asthma walk for 2 hours along two different routes
- Larger decline in lung function after walking more polluted route



McCreanor J, et al. 2007, NEJM

Long-term Exposure and Asthma Incidence

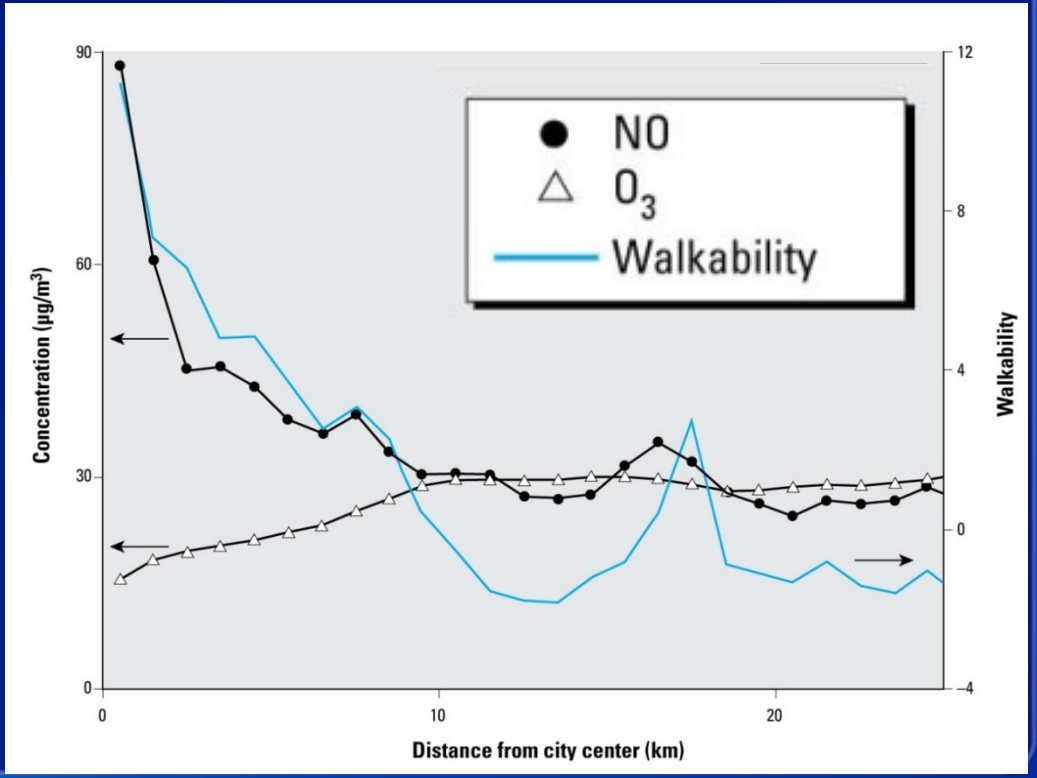
- Cohort study of 3,535 children 9–16 yrs
- Southern California, 1993–1998
- Playing ≥3 sports increased risk of asthma in high ozone communities, but not in low ozone communities

	Low ozone communities		High ozone communities	
	N (incidence)*	RR (95% CI)	N (incidence)*	RR (95% CI)
Number of sports played				
0	58 (0·027)	1·0	46 (0·018)	1·0
1	50 (0·033)	1·3 (0·9–1·9)	40 (0·021)	1·3 (0·8–2·0)
2	20 (0·023)	0·8 (0·5–1·4)	16 (0·020)	1·3 (0·7–2·3)
⩾3	9 (0·019)	0·8 (0·4–1·6)	20 (0·050)	3·3 (1·9–5·8)

McConnell R, et al. 2002, Lancet

Role of the Built Environment

- **Neighborhood walkability and air pollution concentrations correlated (Vancouver, Canada)**
- **Compare ischemic heart disease mortality in So. Cal neighborhoods**
- **High-walkable:**
  - 7 deaths from increased physical activity
  + 6 more deaths from increased air pollution (+ 9 $PM_{2.5}$ – 3 O_3)



Marshall JD, et al., 2009 Environ Health Perspect; Hankey S et al. 2012 Environ Health Perspect

CDC ACTIVITIES

CDC Physical Activity and Air Quality Workshop

- **Panel of 25 scientists from physical activity and air pollution disciplines**
- **Atlanta, April 2010**

- **Workshop objectives:**
  - Review state of the science
  - Provide recommendations to CDC on how to advise the general public and public health officials on physical activity in regard to outdoor air quality

CDC Workshop Findings: State of the Science

- **A large body of evidence within each discipline**
- **More research is needed to address intersection of physical activity and air pollution exposure**

- **Subset of workshop attendees working on a paper to advance the evidence base:**
  - Highlight need for better understanding about the intersection of physical activity and air pollution
  - Propose an integrated research approach
  - Inform evidence-based policies and recommendations

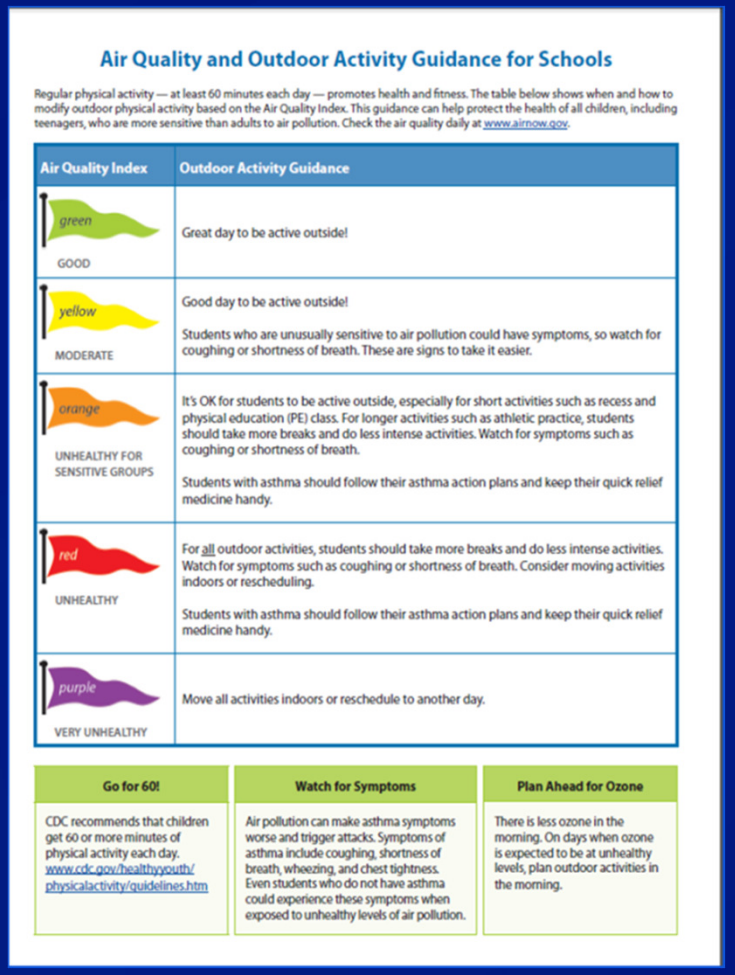
CDC Workshop Findings: Public Health Guidance

- **Promote physical activity while reducing risk from outdoor air pollution exposure**
- **Outline factors that impact risk:**
  - Individual susceptibility
  - Likelihood of exposure (when, where)
  - Level of physical activity (duration, intensity)
  - Type of pollutant
- **Consider unique communication needs of subpopulations**
- **Improve air quality (primary prevention)**

Air Quality & Outdoor Activity Guidance for Schools

- EPA and CDC collaboration
- Update physical activity guidance associated with the School Flag Program
- Goal: Keep kids active!
- Take into consideration that air pollution exposures during school day are of short duration
  - 15 minute recess
  - 30 minute PE class

http://www.cdc.gov/air/air_health.htm



Air Quality and Outdoor Activity Guidance for Schools

Regular physical activity — at least 60 minutes each day — promotes health and fitness. The table below shows when and how to modify outdoor physical activity based on the Air Quality Index. This guidance can help protect the health of all children, including teenagers, who are more sensitive than adults to air pollution. Check the air quality daily at www.airnow.gov.

Air Quality Index	Outdoor Activity Guidance
green — GOOD	Great day to be active outside!
yellow — MODERATE	Good day to be active outside! Students who are unusually sensitive to air pollution could have symptoms, so watch for coughing or shortness of breath. These are signs to take it easier.
orange — UNHEALTHY FOR SENSITIVE GROUPS	It's OK for students to be active outside, especially for short activities such as recess and physical education (PE) class. For longer activities such as athletic practice, students should take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. Students with asthma should follow their asthma action plans and keep their quick relief medicine handy.
red — UNHEALTHY	For all outdoor activities, students should take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. Consider moving activities indoors or rescheduling. Students with asthma should follow their asthma action plans and keep their quick relief medicine handy.
purple — VERY UNHEALTHY	Move all activities indoors or reschedule to another day.

Go for 60!	Watch for Symptoms	Plan Ahead for Ozone
CDC recommends that children get 60 or more minutes of physical activity each day. www.cdc.gov/healthyyouth/physicalactivity/guidelines.htm	Air pollution can make asthma symptoms worse and trigger attacks. Symptoms of asthma include coughing, shortness of breath, wheezing, and chest tightness. Even students who do not have asthma could experience these symptoms when exposed to unhealthy levels of air pollution.	There is less ozone in the morning. On days when ozone is expected to be at unhealthy levels, plan outdoor activities in the morning.

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State Asthma Control Program Activities

- **Utah: developed "Recess Guidance for Schools" based on outdoor air quality**
  - Provide link to daily air quality and resources for keeping students with asthma healthy and safe
  - Developed three tutorials (available on website)
  - Email recess air quality alerts to 240 school personnel
  - 84% of principals/staff aware of and used guidance

http://www.health.utah.gov/asthma/schools/aq_guidelines.html

State Asthma Control Program Activities

- **Minnesota: developed "Air Quality Guidance for Schools and Child Care Facilities"**
  - Provide alternatives to outdoor activities, including San Joaquin Valley's Active Indoor Recess (AIR) curriculum www.valleyair.org/programs/ActiveIndoorRecess/intro.htm
- **Indiana: promote "Fly a Flag for Clean Air" program**
  - Notify school and neighborhood about daily air quality
  - Also adopt no-idling and tobacco-free campus policies

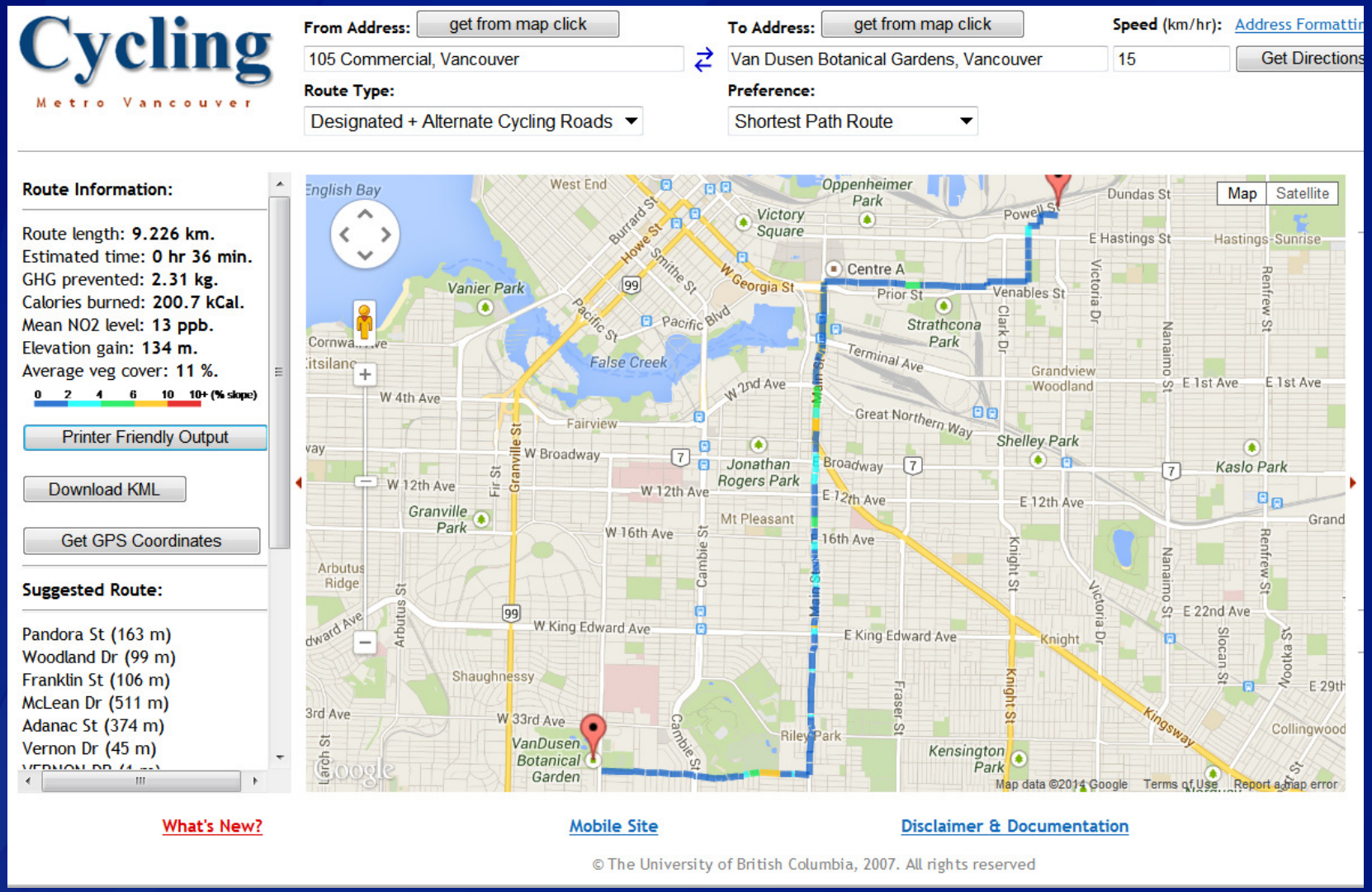
http://www.health.state.mn.us/divs/hpcd/cdee/asthma/school.html
http://www.in.gov/isdh/25321.htm

MOVING FORWARD

Physical Activity and Air Pollution Guidance – Exposure Issues

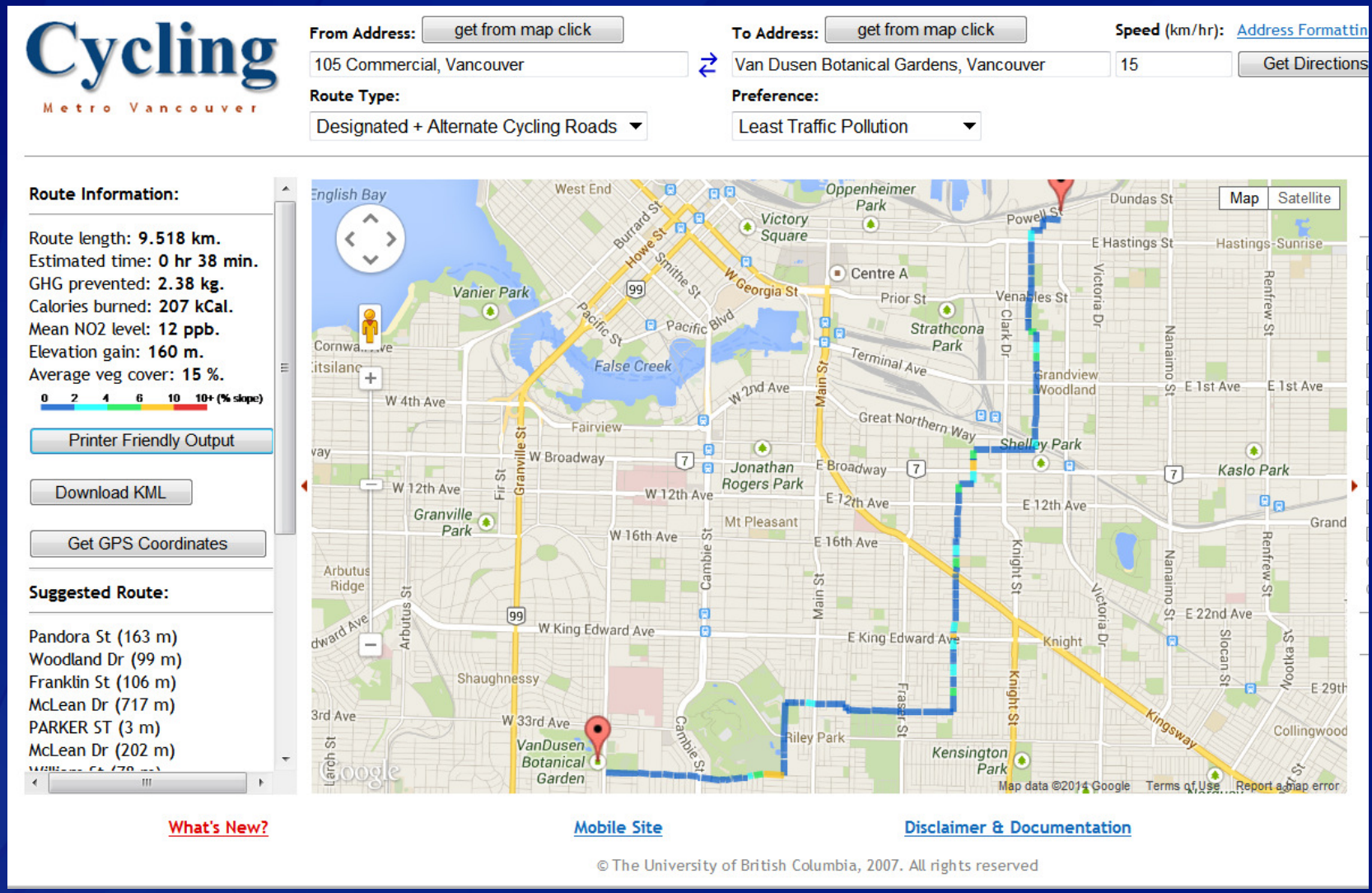
- **Local air pollution levels needed to help inform individual's physical activity decisions**
  - Compare concentrations between different routes
  - Vancouver Cycling Route Planner http://www.cyclevancouver.ubc.ca/cv.aspx
- **Consider the proportion of total air pollution dose resulting from physical activity**

“Shortest path” route



http://www.cyclevancouver.ubc.ca/cv.aspx

“Least traffic pollution” route



http://www.cyclevancouver.ubc.ca/cv.aspx

Physical Activity and Air Pollution Guidance – Messaging Issues

- **Make it applicable to all types of physical activity, not just "exercise"**
  - Travel, household, occupational, and leisure-time
- **Address at-risk populations**
- **Address microenvironments**
  - Proximity to major roads, urban/rural settings
  - Time of day, seasonality
- **Encourage physical activity and time outdoors!**

Change the Paradigm

Thank You

Contact information:
Tegan Boehmer, PhD, MPH
tboehmer@cdc.gov

For more information please contact Centers for Disease Control and Prevention
1600 Clifton Road NE, Atlanta, GA 30333
Telephone, 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov Web: www.cdc.gov